WHAT IS CLAIMED IS:

1. An illumination device having
   - a light source (1);
   - an optical waveguide;
   - a coupling-in optical system (3) which couples the light of said light source (1) into a first end of said waveguide;
   - a coupling-out optical system (5) which couples out the light emerging from a second end of said optical waveguide; and
   - an illuminating optical system (17; 20) which receives the light emerging from said coupling-out optical system (5) and illuminates an image field,

   comprising:

   a) an optical fiber bundle (4) which is arranged as said optical waveguide; and

   b) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17; 20), wherein said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from said optical fiber bundle (4).

2. An illumination device having
   - a light source (1);
   - an optical waveguide;
   - a coupling-in optical system (3) which couples the light of said light source (1) into a first end of said waveguide;
   - a coupling-out optical system (5) which couples out the light emerging from a second end of said optical waveguide; and

- an illuminating optical system (17; 20) which receives the light emerging from said coupling-out optical system (5) and illuminates an image field,

comprising:

a) an optical fiber bundle (4) which is arranged as said optical waveguide; and

b) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17; 20), wherein said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from said optical fiber bundle (4),

c) wherein said homogenizing optical system (6) comprises a micro-honeycomb condenser (7) and a lens member (8) which superimpose the exit opening of said fiber bundle (4) in an intermediate image plane (10) to form a homogeneous intermediate image.

3. An illumination device having

- a light source (1);
- an optical waveguide;
- a coupling-in optical system (3) which couples the light of said light source (1) into a first end of said waveguide;
- a coupling-out optical system (5) which couples out the light emerging from a second end of said optical waveguide; and
- an illuminating optical system (17; 20) which receives the light emerging from said coupling-out optical system (5) and illuminates an image field,

comprising:

a) an optical fiber bundle (4) which is arranged as said optical waveguide; and

b) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17;

20), wherein said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from said optical fiber bundle (4),

c) wherein the light of said light source (1) is picked off via said coupling-in optical system (3) having a large numerical entrance aperture and is coupled into said optical fiber bundle (4).

4. An illlumination device having

- a light source (1);
- an optical waveguide;
- a coupling-in optical system (3) which couples the light of said light source (1) into a first end of said waveguide;
- a coupling-out optical system (5) which couples out the light emerging from a second end of said optical waveguide; and
- an illuminating optical system (17; 20) which receives the light emerging from said coupling-out optical system (5) and illuminates an image field,

comprising:

d) an optical fiber bundle (4) which is arranged as said optical waveguide; and

e) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17; 20), wherein said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from said optical fiber bundle (4),

f) wherein the light of said light source (1) is picked off via said coupling-in optical system (3) having a large numerical entrance aperture NA $\geq$ 0.60 and is coupled into said optical fiber bundle (4).

5. A coordinate measuring instrument having

- a horizontally X-Y displaceable measurement stage (26) for receiving a substrate with a feature (31) that is to be measured;

- an illumination system with a light source (1), an optical waveguide (4), a coupling-in optical system (3) before the optical waveguide (4), a coupling-out optical system (5) after the optical waveguide (4), and an illuminating optical system (17; 20) for illuminating an image field; and
- a detector device (14) for determining the position of the feature,

comprising:

a) an optical fiber bundle (4) which is arranged as said optical waveguide; and

b) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17; 20), said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from the optical fiber bundle (4).

6. A coordinate measuring instrument having

- a horizontally X-Y displaceable measurement stage (26) for receiving a substrate with a feature (31) that is to be measured;
- an illumination system with a light source (1), an optical waveguide (4), a coupling-in optical system (3) before the optical waveguide (4), a coupling-out optical system (5) after the optical waveguide (4), and an illuminating optical system (17; 20) for illuminating an image field; and
- a detector device (14) for determining the position of the feature,

comprising:

a) an optical fiber bundle (4) which is arranged as said optical waveguide;

b) a homogenizing optical system (6) which is arranged between the coupling-out optical system (5) and the illuminating optical system (17; 20), said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from the

optical fiber bundle (4), said homogenizing optical system (6) comprising a micro-honeycomb condenser (6) and a lens member (8) which superimpose the exit opening of the fiber bundle (4) in an intermediate image plane (10) to form a homogeneous intermediate image.

7. A coordinate measuring instrument having
   - a horizontally X-Y displaceable measurement stage (26) for receiving a substrate with a feature (31) that is to be measured;
   - an illumination system with a light source (1), an optical waveguide (4), a coupling-in optical system (3) before the optical waveguide (4), a coupling-out optical system (5) after the optical waveguide (4), and an illuminating optical system (17; 20) for illuminating an image field; and
   - a detector device (14) for determining the position of the feature,

   comprising:
   a) an optical fiber bundle (4) which is arranged as said optical waveguide;
   b) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17; 20), said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from the optical fiber bundle (4).
   c) wherein the light of said light source (1) is picked off via said coupling-in optical system (5) with a large numerical entrance aperture, and is coupled into said optical fiber bundle (4).

8. A coordinate measuring instrument having
   - a horizontally X-Y displaceable measurement stage (26) for receiving a substrate with a feature (31) that is to be measured;

- an illumination system with a light source (1), an optical waveguide (4), a coupling-in optical system (3) before the optical waveguide (4), a coupling-out optical system (5) after the optical waveguide (4), and an illuminating optical system (17; 20) for illuminating an image field; and
- a detector device (14) for determining the position of the feature,

comprising:

a) an optical fiber bundle (4) which is arranged as said optical waveguide;

d) a homogenizing optical system (6) which is arranged between said coupling-out optical system (5) and said illuminating optical system (17; 20), said homogenizing optical system (6) homogenizes the nonuniform intensity distribution in the image field of the light emerging from the optical fiber bundle (4).

e) wherein the light of said light source (1) is picked off via said coupling-in optical system (5) with a large numerical entrance aperture $NA \geq 0.60$, and is coupled into said optical fiber bundle (4).